N84-25018

FINAL REPORT

to

GEORGE C. MARSHALL SPACE FLIGHT CENTER

DESIGN AND CONSTRUCTION

of

EQUIPMENT ITEMS

for

GEOPHYSICAL FLUID FLOW MODELS

CONTRACT NO. NAS8-35023
(DCN 1-2-ES-26580)

prepared by:

O. C. HOLDERER

March 29, 1984

Distribution:

ES82	2 cy.
AT01	1 "
AS24-D	3 "
EM12-B	cy. of cover only
AP25-G	" " " "

Approved:

William W. Fowlis

W. W. Fowlis, ES74

Precision Devices, Ltd. 2304 OAKWOOD AVENUE. N. W.
HUNTSVILLE, ALABAMA 35810

TABLE OF CONTENTS:

FIGURES:

A. SUMMARY:

Contract NAS8-35023 was entered into on 8-2-82. The scope of work defined the design and development of five specific end items which had no direct relation to each other except that they were all needed for 'Geophysical Fluid Flow' models.

The contract was amended three times, cost was not affected in the amendments. Amendment SA #1, dated Jan. 28, 1983 allowed incremental payment and the nomenclature of the end items was simplified thus:

A.	Thermometer Well	243.00
B.	Thermistor Probe	1,393.00
C.	Conducting Sidewalls	2,814.00
D.	Precision Controllers	2,461.00
E.	Baroclinic Chamber	12,869.00
		$19,780.00

Delivery for items A through D was made between August 82 and April 83. Priorities were selected by the C. O. R. Preparation of layouts for item E (Baroclinic Chamber) were begun in June 1983 and the basic outline dimensions were agreed to by the C. O. R., so that the expensive, long lead-time saphire disks needed for the chamber, could be ordered. For reasons related to MSFC internal research activities, the C. O. R. put a hold on the chamber design. This necessitated extensions of the contract, S/A 2 extension to February 6, 1984 and S/A 3 extension to June 6, 1984. The C. O. R. gave the go-ahead for a revised Baroclinic Chamber in Dec. 1983. The saphire windows were already on hand the purchase of other subcomponents was initiated. Fabrication commenced in early Feb. 1984 and the total assembly was finished, inspected and thoroughly tested during March 1984, with delivery scheduled for March 29, 1984.

B. NEW TECHNOLOGY:

The efforts under this contract did not result in patentable inventions or 'new technology' which would be of general benefit. The equipment is highly specialized and devoted to specific scientific experiments. The MSFC New Technology manager has been advised of the above and an interim report was mailed to him on Sept. 22, 1983.

C. THERMOMETER WELL:

The thermometer well (formerly referred to as the circulating fluid temperature measuring assembly) is shown on dwg. MS 882-1, dated Aug. 31, 1983. The well allows the accurate temperature measurement of four fluid circuits. Each circuit features a "well" into which a precision, laboratory type thermometer is inserted and held in place by closed cell foam washers in a sealing gland. The inlet - outlet ports accept 1/2" I.D. Tygon tubing. The wells are surrounded by a rigid urethane insulating foam, injected in situ as shown on dwg. (see fig. 1)

D. THERMISTOR PROBE:

1. General

A miniaturized temperature probe mount for use in the 'Shallow Annulus' for the 2 cm high chamber has been designed. The device is fully documented on drawing No. MS 383-0, dated March 11,83 and it consists of three essential elements:

1) The Thermistor Probe Rake,
   which is immerged in the test fluid,
2) The Traversing Mechanism
   which attaches to the annulus apparatus and rotates with it on the turntable during an experiment.
3) The Traversing Controller
   which is held stationary from an upright column of the turntable assembly.

A 3-position control lever permits remote position changes of the thermistor rake. The three options are for inward or outward movement of the rake and stationary.

2. THERMISTOR PROBE

The probe is shown on dwg. MS 383-1. The primary design goal was miniaturization. Four glass-stemmed mini-thermistors are mounted to a brass cross bar which is, in turn, mounted to a hypodermic stainless steel tube of only 1.1 mm dia. Eight # 37 gage magnet wires are housed in the tube and soldered to the 0.05 mm dia. platinum leads of the thermistors. The thermistor bead locations are shown on the drawing, that is, the spacing between beads is 5 mm and the distance away from the tube centerline is also 5 mm. It is obvious that the rake assembly is an extremely delicate instrument which must be handled with the greatest care. Note that the glass rod diameter of the thermistors is only 0.35 mm. The rake must be installed from the inside of the annulus wall, starting with the # 37 leads being threaded through the O-ring and guide. After positioning the probe, and clamping it to the traverse mechanism, the lead wires are soldered to the 8-pin receptacle. Identification of the lead wires is a problem because of their small size and lack of color coding.

It is suggested to accomplish identification by the use of a pipette filled with alcohol or similar fast-evaporating fluid (not water) and letting a drop fall on the bead. The cooling effect will cause a drastic resistance increase accross the corresponding leads. The electrical and mechanical specifications of the thermistors are given in the brochures by the manufacturer, Thermometrics, Inc. Note that the dissipation constant is only 0.16 milliwatt per degree centigrade. The four thermistors in the rake have been resistance matched. The average resistance is 6000 Ohm at 22° C. CAUTION: Because of the exposed thermistor lead connections, the probe must not be used in a conductive or corrosive test fluid. (See Fig. 2)

3. TRAVERSING MECHANISM

The traversing mechanism uses a # 10-24 lead screw, i. e. each turn of the lead screw causes the probe to traverse 1/24" = .0417" or 1.058 mm. A four-bobbed star wheel drives the lead screw in 1/4 turn increments which equals 0.01043" or 0.2648 mm. The traversing mechanism has a 50 mm mechanical range. This range must be limited by stops as necessary to avoid damage to the rake or the position potentiometer respectively. The latter has a range of 32 mm at 41 K Ohm. 1.28 K Ohm represent 1 mm traversing motion. Because of inevitable backlash, it will be necessary to calibrate the position potentiometer for the "in" and "out" drive condition separately.

4. TRAVERSING CONTROLLER

The controller features two retractable interceptive rods which engage the star wheel of the traversing lead screw. As the turntable rotates, the star wheel is "intercepted" once per revolution, causing it to rotate 1/4 turn. The direction of rotation (in or out traverse) depends on the choice of interceptor rod placed in the engagement position. Both rods can also be placed in a "neutral" position. To avoid damage should either of the end position (stops) of the traverse slide be reached, an automatic cut-out feature has been incorporated in the controller. The interceptor rod base plate swivels away when the interceptor rod contact force exceeds a predetermined limit. The break-away force is controlled by a spring loaded ball-indent mechanism attached to the interceptor rod base plate.

E CONDUCTING SIDEWALLS

The diameters of the conducting sidewalls (inner and outer) were specified in the contract. The inner wall has a 2" dia. and the outer wall has a 5" dia. The test volume hight was selected by the C. O. R. to be 2 cm (.787"). The design is shown clearly on the assembly drawing MS 1082-1. The ideas

advanced in the proposal were followed. The inner sidewall consists of a cylindrical brass plug with a suction piston. The piston dia. was kept small enough so as not to affect the thermal contact area significantly (only 35% of the 3.14 square inch area is "used up" by the piston and the sealing ring.) A locating ring (not shown on the drawing) has been provided to facilitate concentric installation of the inner sidewall. All 'new' parts have been detailed on individual drawings MS 1082-2 through - 6. As before, the shallow annulus assembly is clamped together in a yoke as shown on drawing MS 981 - 1. This yoke features a single, centrally located, clamping screw. This was sufficient, when the insulating sidewalls were used, however, for the conducting sidewalls it is important that firm physical contact is established between the saphire disks and the sidewalls. Therefore, four tie rods were added to aid the clamping. To minimize thermal 'cross talk' between the upper and lower saphire assemblies through the steel tie rods, the rods penetrate the aluminum heat sinks with ample clearance (air gap) and nylon bushings are placed under the nuts at the upper disk assembly. - In all other respects, the shallow assembly with thermal conducting sidewalls is identical to the non-conducting version. (See Fig. 3)

F. PRECISION CONTROLLERS

1. General

The selection and design of the sensitive temperature controllers were predicated by the high accuracy required, by the limited space available on the turntable and the necessary overall ruggedness and compatibility with the "Shallow Annulus" experiment. The Model CA 4261 integral solid state proportional temperature controller (Thermalogic Corp., Waltham, Mass.) was selected as a best match. It is compatible with the existing thermistor sensors (type 1122 H custom encapsulated for the "Shallow Annulus").

The commercial components were packaged into a self contained assembly as shown on drawing MS 1082 - 10. This drawing is an isometric view and identifies all functionally important elements. Noteworthy are the LED pilot lights, red for power on indication, and green shows the pulsed power output from the triac to the heater element. The mounting bracket provides interchangeability and easy attachment to the "Shallow Annulus" base plate without modification.

2. Electro-mechanical Features

The Model CA 4261 is a compact, fully encapsulated unit which tolerates hostile environments such as moisture, elevated temperatures and shock. A high speed fuse (.5 A) has been incorporated to protect the triac in case of a shorted heater. The desired temperature is directly dialed with a calibrated potentiometer with a range of 20 to 50^{o} C. Each division represents .25^{o}C. A U.L. Class II transformer isolates the controller (not triac) from line voltage for protection from transients and ground faults. The controller circuit is fail safe, that is, the power to the load (heater) is automatically turned off if the sensor develops a short or open circuit. The proportional band width (sensitivity) is adjustable (.25 - 2.5^{o}C). The adjustment potentiometer is located within the controller housing and has been set to the most sensitive position (.25^{o}C.) This rather narrow band width results in a slight "overshoot" from large transients, e. g. when the unit is initially turned on or when the dial setting is changed. Of course, phenomena such as overshoot are system-dependent, and for the "Shallow Annulus Assembly", the overshoot amounts to less than .2^{o}C, followed by an undershoot of less than .05^{o}C. The transients dampen out completely within less than a minute. Once the sensed temperature is within the band width of the controller, the triac is pulsed on and off at a constant frequency of about 1.3 cycles per second. This is evident by the blinking of the green LED display light.

Control is achieved by proportioning the ratio between the "on" time and the "off" time. The anticipatory (derivative) control circuit provides the constant "updating" of the pulse width for a tight control.

3. Bench Test at PRECISION DEVICES, LTD.

The completed units (2) were subjected to a functional test and calibration. A digital ohmeter (four significant places) was connected to the sensor thermistor probe. This probe is identical to the control thermistor but electrically and mechanically completely independent. The control and sensing thermistors are mounted diagonally opposite on the heavy aluminum heat sink ring which carries the saphire disk in the middle and the heater element at the periphery. The thermistor has a resistance of 2252 ohms at 25°C and 1470 ohms at 35°C respectuvely. Thus a 1°C temperature change represents a resistance change of 78.2 ohms. With the aforementioned meter it was thus possible to observe changes in the order of 1/100°C. The controller was set to 35°C. The ambient temperature was approximately 23°C. After the saphire assembly reached set point temperature, a slight overshoot of less than .2°C was observed. This was followed by an undershoot of about .05°C, hence the controller "locked in" and the temperature was held steady within 2 counts, which is equivalent to plus-minus .013°C. The test was conducted for 12 hours with the ambient temperature changing by more than 5°C. "Mild transients" were introduced by grasping the aluminum heat sink with "cold" hands. The controller action was prompt and precise. The temperature did not deviate more than 3 counts (.04°C) up or down from the mean.

4. Summary

Inherently, the "Shallow Annulus" experiments do not incur harsh transients during a test run - perhaps no worse than the "cold hands simulation" - the controller should easily keep the set

temperature constant to better than .1^{o}C, which was stipulated in the contract. (See Fig. 4)

G. BAROCLINIC CHAMBER

1. Design

The baroclinic chamber is to be mounted on MSFC's new 36"dia. rotating table, and the mounting provisions have been located accordingly. Also, it was necessary to provide about 2 1/4" of clearance under the mounting ring, because the manifold for the thermostated cooling - heating fluids is located in the center on top of the table. As shown on dwg. MS 783-0, revision C, dated 3-22-84, three columns support a large diameter acrylic ring, which, in turn supports the lower saphire disk assembly. This assembly includes the aluminum mounting ring which has a crossection of approx. 1 x 1". The aluminum ring contains a 3/8" dia. copper tube through which thermostated (cold) water is circulated. The two hose connectors are dimensioned for 1/2" I.D. Tygon tubing. The 5" I.D. acrylic sidewall of the chamber carries an acrylic 'spill basin' near the top. Eight #6-32 tie rods hold the entire lower assembly together and provide the necessary pressure on the O-ring seal in the aluminum ring. - The upper saphire disk is also bonded to a 1 x 1" crossection aluminum ring, however, this ring has an embedded electrical heater. The upper saphire is supported by an acrylic disk, which holds it to a precision ball bearing mounted spindle. Three spider-like arms extend from the central bearing housing. The arms rest on the three columns, which also hold the lower saphire assembly. Fine adjustment features at the spider arm - column interface have been incorporated for perfect concentricity and minimum clearance between the upper saphire and the edge of the cylindrical wall. The 'spill basin' holds any liquid which escapes through the gap. The upper saphire assy. is driven through an O-ring - in vee-belt fashion-from a stepper motor. (See Fig. 5)

2. Rotating Speed Measurement

A permanent magnet has been mounted to the aluminum ring of the upper saphire and a compatible proximity switch (reed type) is fastened to the stationary columns. The obvious purpose of this arrangement is the accurate measurement of the relative rotational speed of the upper disk. An external (not furnished) period counter is used to clock the time lapse per revolution.

3. Temperature Control

As mentioned, the heater is imbedded in the aluminum ring. Great care was taken to assure a uniform heat distribution in the ring, there is virtually no 'splice' in the 3/8"dia. heater ring. Two 1/4 - 20 tapped holes in the aluminum ring hold the thermistor probes. One probe is used in the control circuit, and the other probe is available for remote recording of the disk temperature. The component specification and the wire color coding through the slipring is shown in Fig. 6. The THERMALOGIC CO. diagram (solid state relay and controller) is shown on Fig. 7.

4. Motor Drive

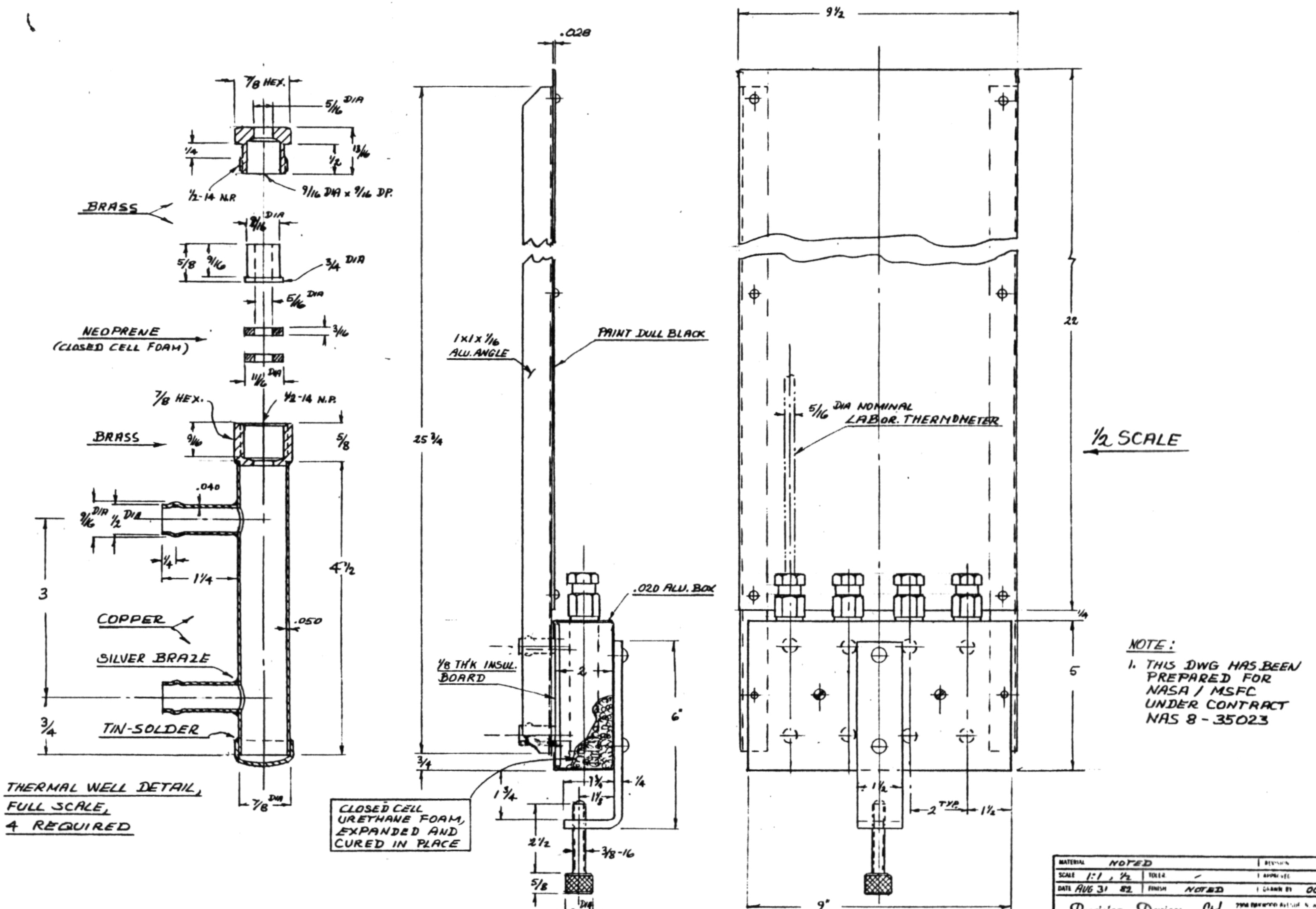
Initially it was planned to employ a speed controlled D.C. gear motor. Since the control of such systems is of an analog nature, the C. O. R. feared that the desired high constancy of the rotational speed might be difficult to achieve. Therefore the drive system uses a stepper motor with appropriate translator. The input is digital from a square wave external low frequency function generator (Not furnished). Since this is a digital system, the speed control is as stable as the function generator. The electrical specifications, model numbers and wiring connections are shown in Fig. 8. - The stepper motor runs reasonably "smooth" between 50 to 600 pulses per second. Four exchangeable motor pulleys (.28 to .935" dia.) are provided for the most accommodating ratio. The drive groove diameter in the aluminum ring is 7", thus the speed reduction ratio between motor and saphire disk ranges from

1:25 to 1:7.5. Since 200 pulses rotate the drive motor one turn, the disk speed range is between .6 to 24 RPM, well within the desired range. The O-ring drive smoothes out the 'jerky' motion of the stepper motor at low speeds, of course there is a lower limit to this damping effect, but that occurs below the specified 1 RPM for the disk. Fig. 9 is a reprint of the motor winding diagram, and figures 10a through 10c describe the 'translator' which drives the stepper motor.

F. CONCLUSION

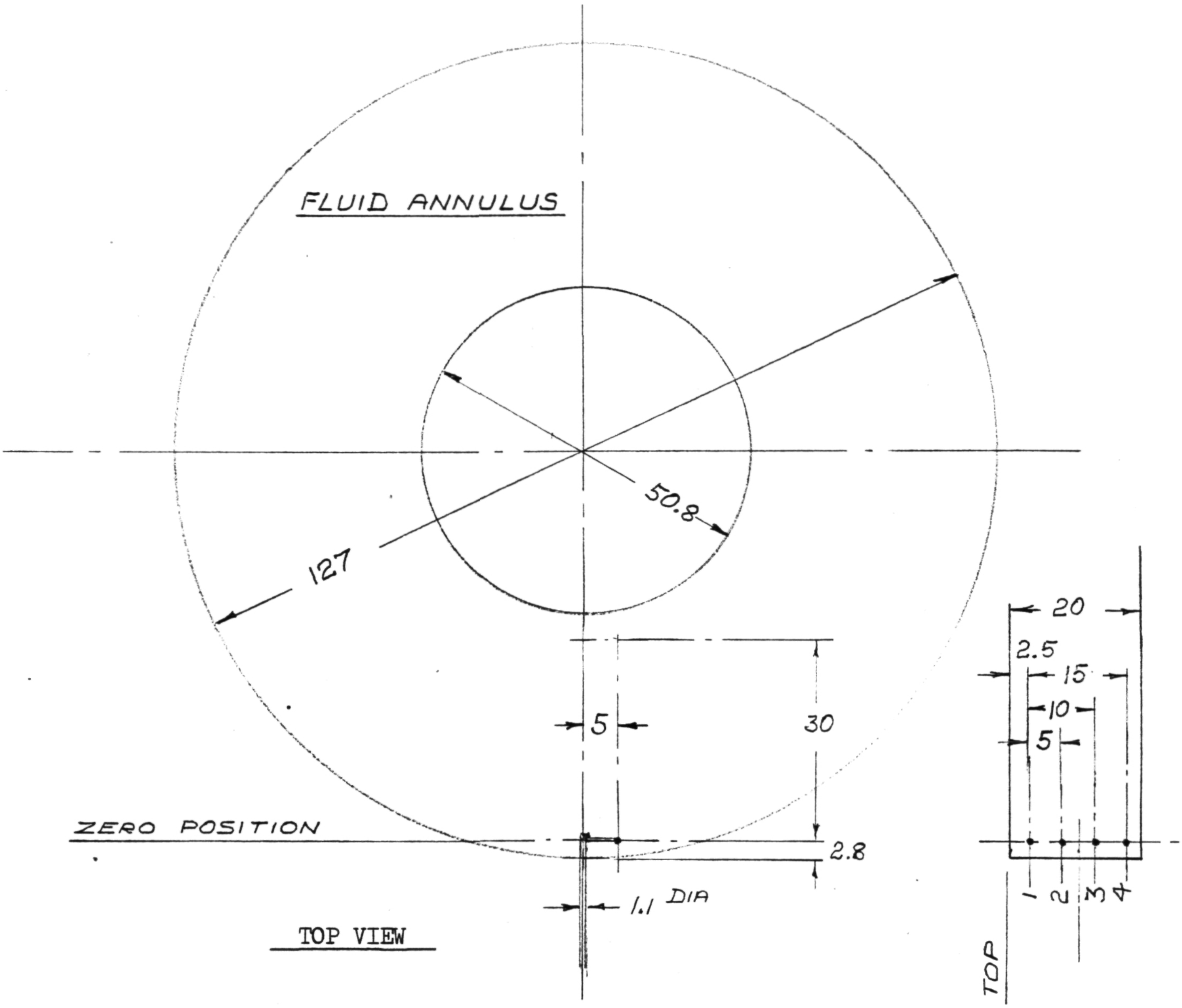
All aspects of the contract have been fulfilled. No government owned equipment was used or incorporated into the end items. The foregoing fully explains the various items which were developed and fabricated as specified. Four of the five items to be delivered under this contract had previously been delivered and accepted, and their performance met all expectations. The last item, the baroclinic chamber, which is being delivered together with this final report, has been thoroughly checked out and should perform equally well. Copies, as required by contract are distributed as follows:

ES 82	2 cy.
AT 01	1 "
AS 24-D	3
EM 12-B	cy. of cover only
AP 25-G	" " " "



MATERIAL NOTED		REVISION
SCALE 1:1, 1/2	TOLER. —	APPROVED
DATE AUG 31 82	FINISH NOTED	DRAWN BY OCH
Precision Devices, Ltd.		
TITLE CIRCULATING FLUID TEMP. MEAS. ASS'Y		DWG No. MS 882-1

FIG 1

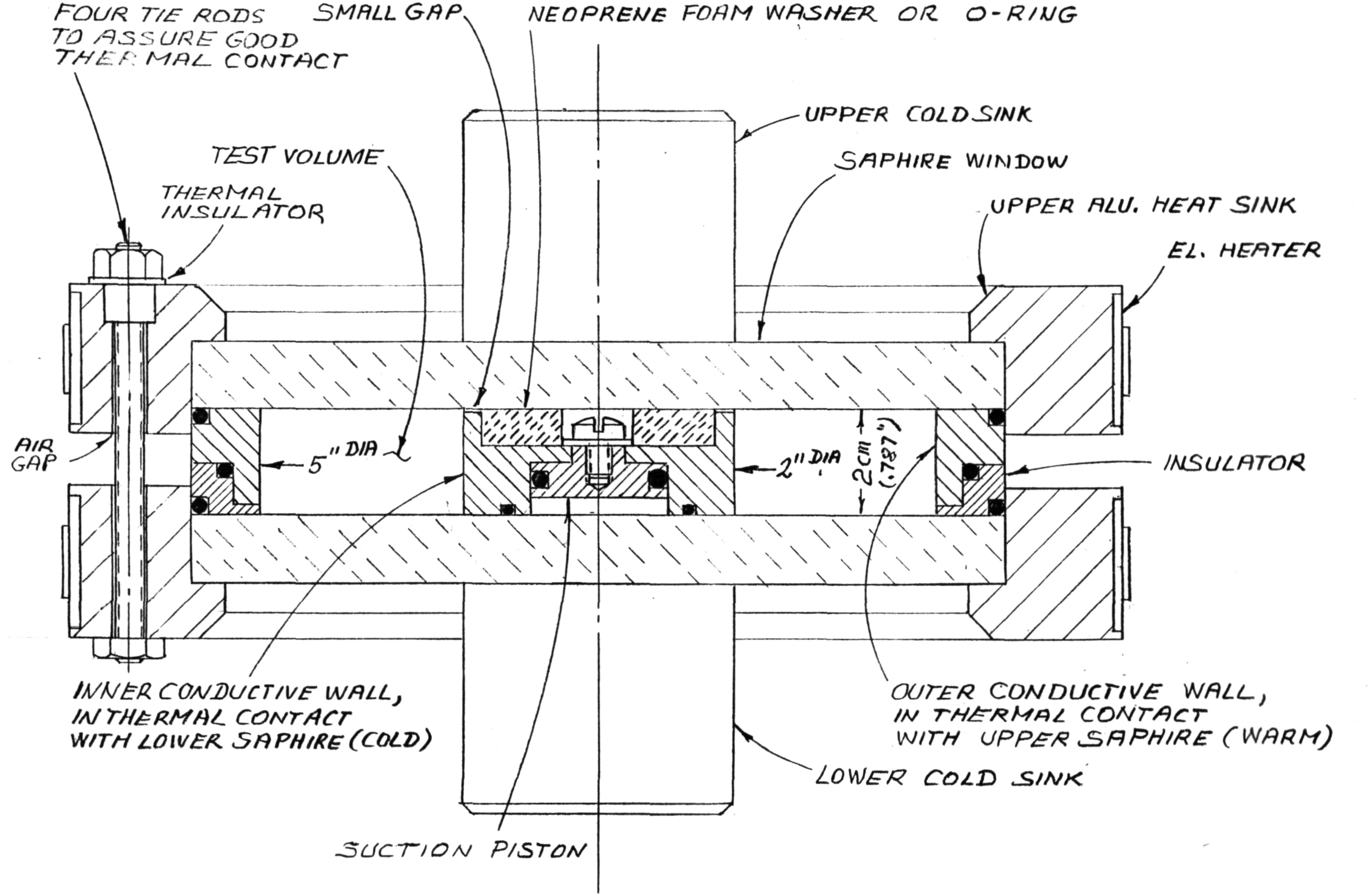


NOTE: 1. ALL DIMENSIONS IN mm

2. CONFIGURATION SHOWN IS FOR 'CONDUCTING SIDEWALLS' ANNULUS WITH CENTERBODY

PROBE GEOMETRY AND THERMISTOR ORIENTATION

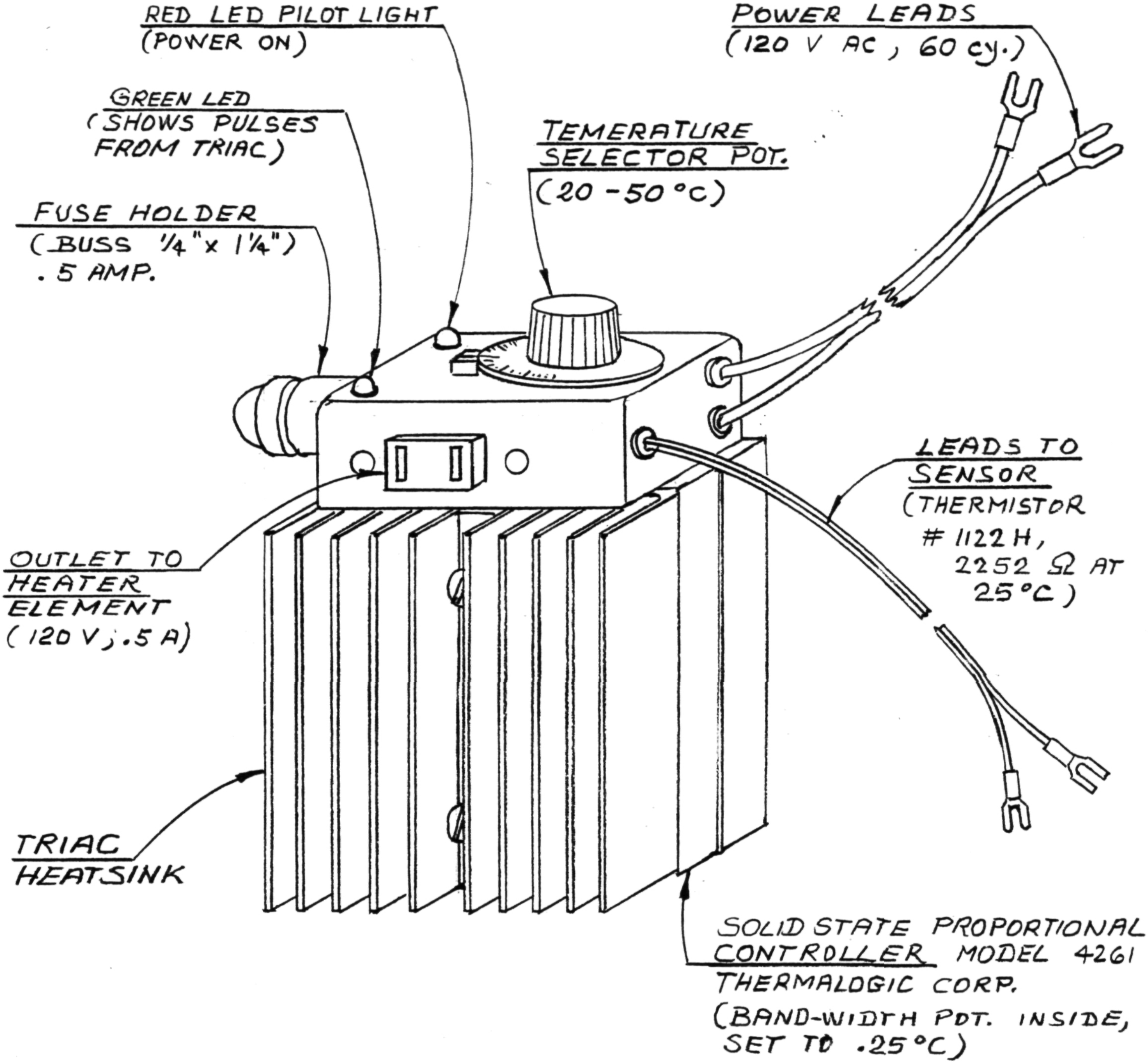
FIG 2



NOTE 1) THIS ITEM FOR NASA-MSFC, CONTRACT NO NAS 8-35023
2) PROVIDE FILLER TUBES AS SHOWN ON DWG MS 981-1.
3) SEE DWG MS 981-1 FOR OTHER DETAIL

CONDUCTING SIDEWALLS

FIG 3



PRECISION CONTROLLER

FIG 4

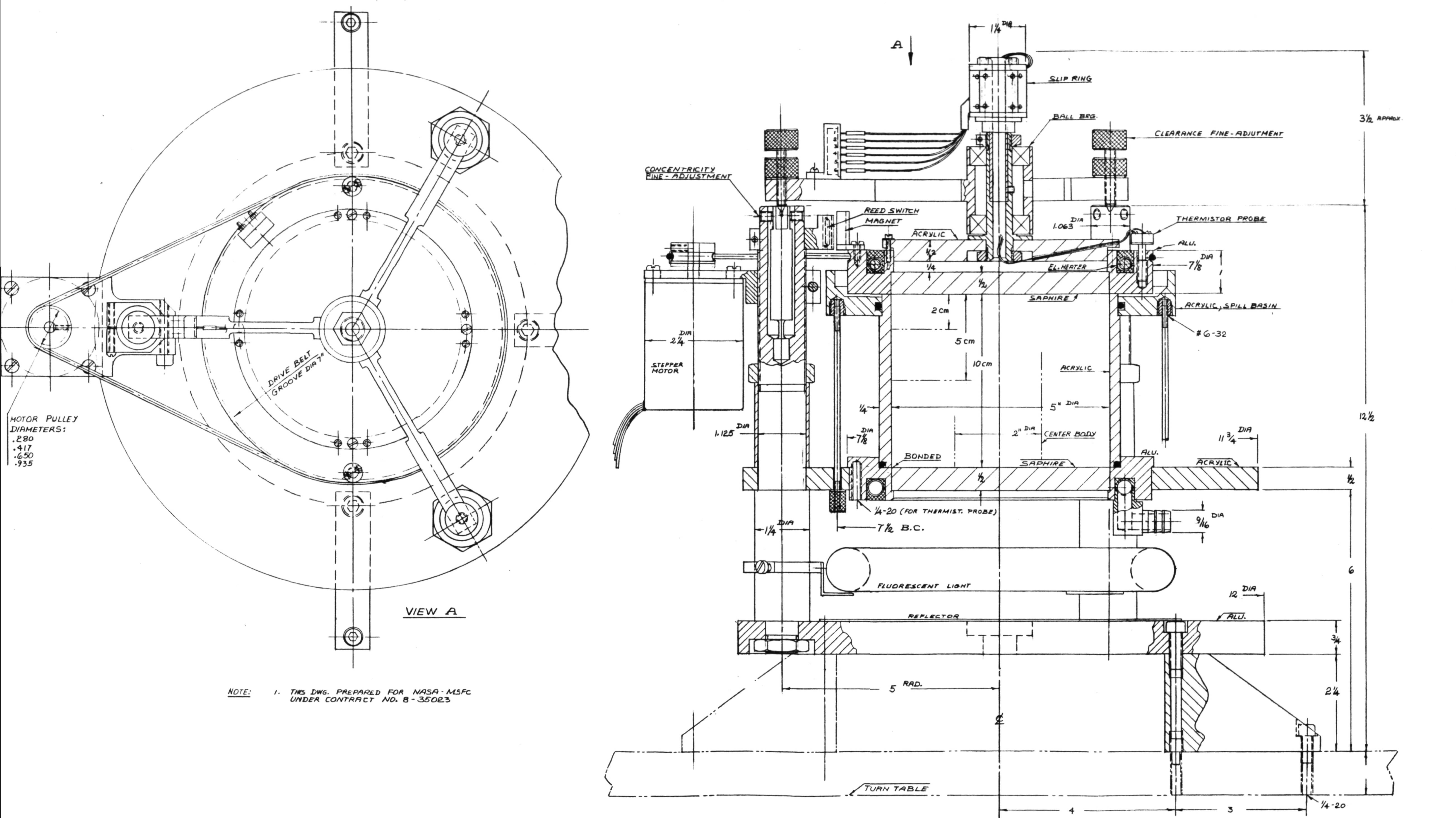
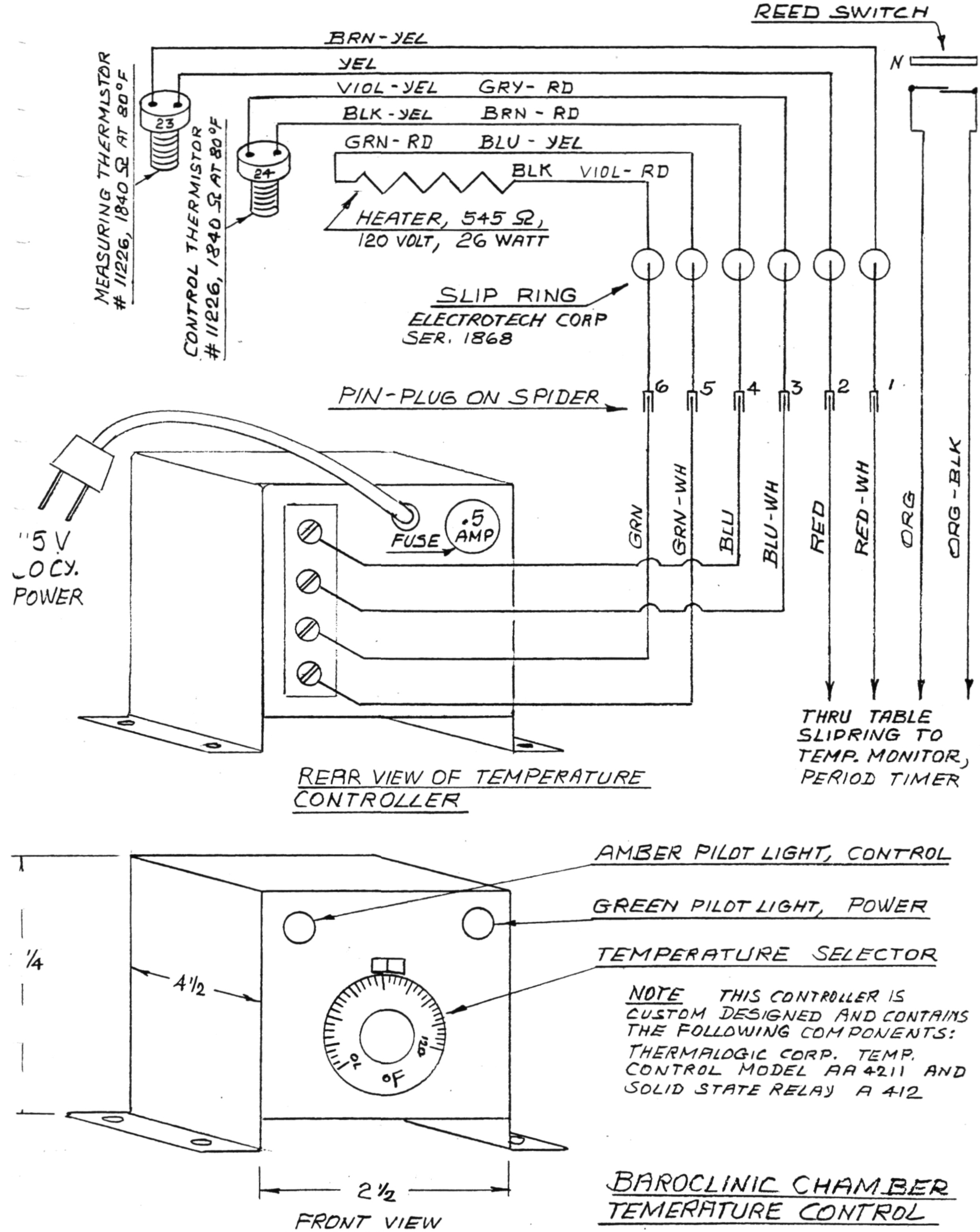


FIG. 5

MATERIAL —		REVISION C 4-22-84
SCALE 1:1	TOLER —	APPROVED
DATE 6-22-83	FINISH —	DRAWN BY DCH
Precision Devices, Ltd.		2304 OAKWOOD AVENUE N.W. HUNTSVILLE, ALABAMA 35810
TITLE CHAMBER ASS'Y		DWG NO. MS 783-0



BAROCLINIC CHAMBER TEMERATURE CONTROL

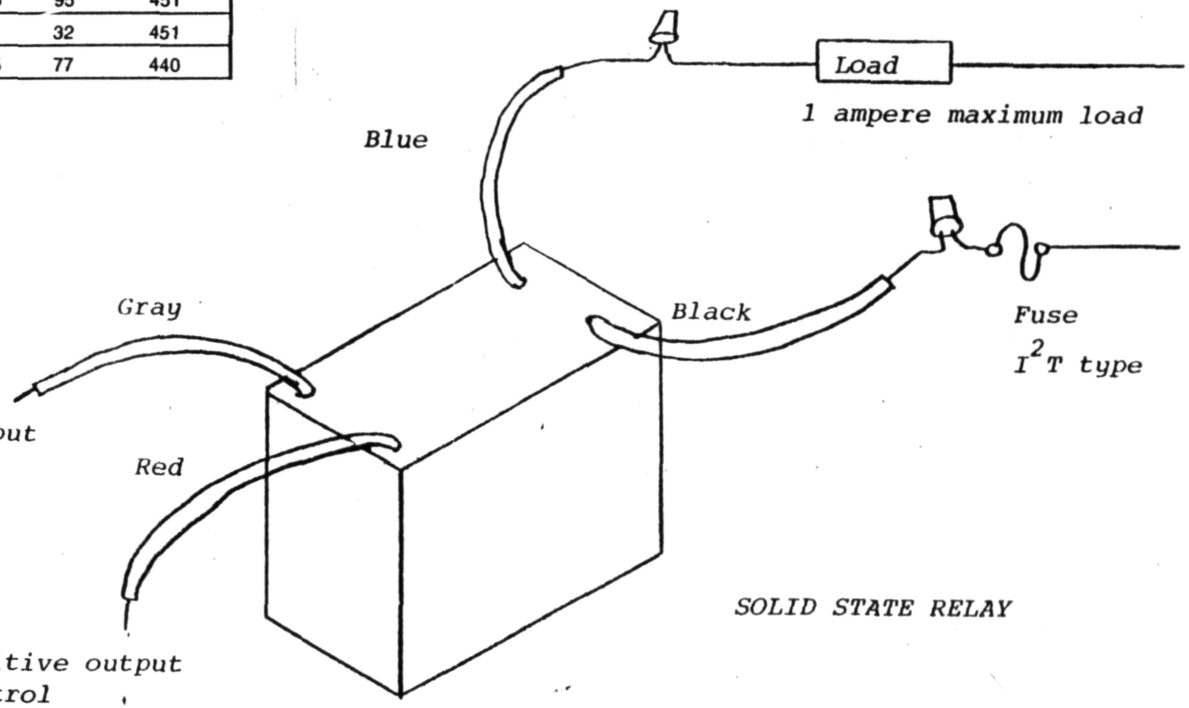
FIG. 6

REV	DESCRIPTION	BY	DATE

THERMISTOR SENSOR (2252 OHMS at 25°C)

10 to 90°C	50 to 194°F	°F 1650 °C 1820	30	90	399
20 to 50°C	68 to 122°F	1470	35	95	445
30 to 50°C	85 to 122°F	1470	35	95	451
−5 to 13°C	23 to 55°F	7320	0	32	451
5 to 35°C	41 to 94°F	2260	25	77	440

1122G



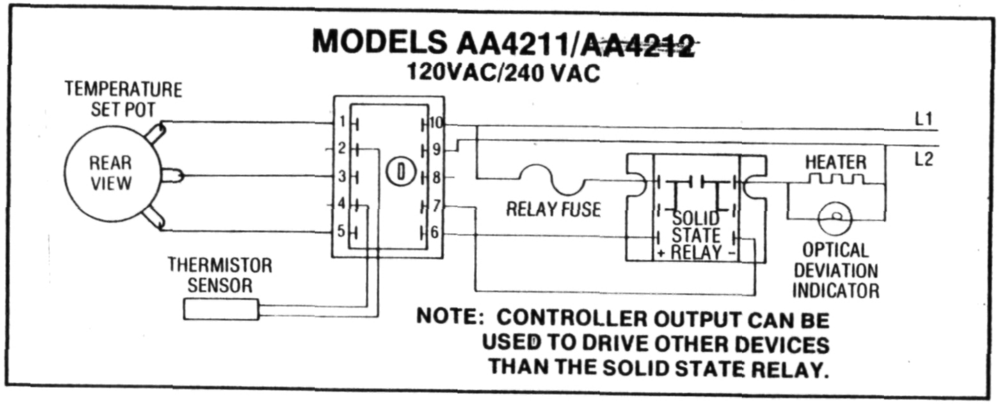
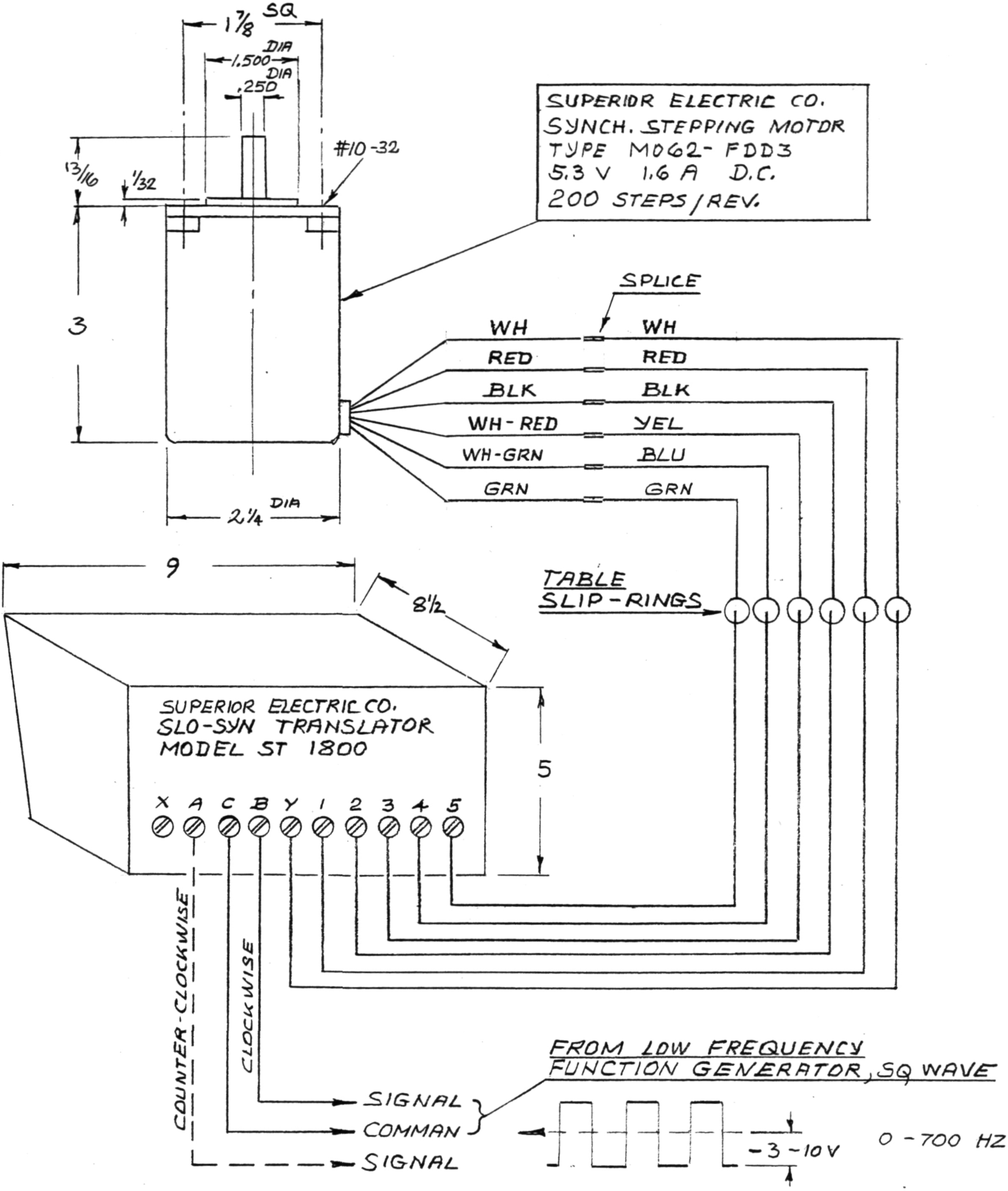


FIG. 7

Thermalogic
Division of DYTRON, Inc.
241 CRESCENT STREET, WALTHAM, MASS. 02154

TITLE Wiring Diagram		
BY R.T.	MODEL NO.	NUMBER A412
APP'D R.T.	DATE 1/27/84	
REV	SHEET of	

TOLERANCE: X = ±.031, XX = ±.015, XXX = ±.005



DRIVE MOTOR WIRING

FIG. 8

SLO-SYN® SYNCHRONOUS MOTORS
5-LEAD and 6-LEAD BIFILAR WOUND MOTORS

INSPECTION — Motors should be inspected for visible shipping damage. Note: Because of the strong permanent magnet, the shaft will not turn freely — even on motors without gears.

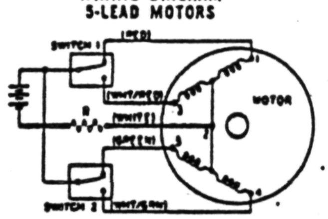
Motors should not be taken apart. Removing the rotor will reduce output torque 5% or more when the motor is reassembled and the permanent magnet will pick up steel chips.

Shielded bearings are used which require no lubrication for the life of the motor.

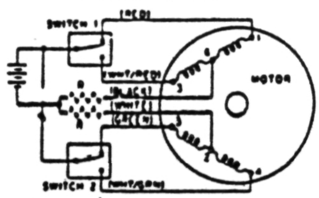
The voltage rating and current per winding are g[illegible] the motor nameplate.

Resistors "R" as shown in the diagrams are u[illegible] limit current to the value given on the motor nam[illegible] If the supply voltage is higher than the meter [illegible] Output torque and maximum speed are increased the L/R time constant is reduced.

WIRING DIAGRAM
5-LEAD MOTORS



WIRING DIAGRAM
6-LEAD MOTORS



SWITCHING SEQUENCE

STEP	CW ROTATION* SWITCH #1	SWITCH
1	1	5
2	1	[illegible]
3	3	[illegible]
4	3	5
1	1	5

*Direction of rotation when [illegible] from nameplate end of mot[illegible] CCW rotation read chart up [illegible] bottom.

THE SUPERIOR ELECTRIC COMPANY
Bristol, Connecticut 06010
PRINTED IN U[illegible]

SE-146832

MOTOR INTERNAL WIRING

FIG. 9

INSTRUCTIONS

for

INSTALLATION, OPERATION and MAINTENANCE

SLO-SYN®

TRANSLATORS TYPES ST250B AND ST1800

and

ADJUSTABLE SPEED DRIVES TYPES ST250B-1015 AND ST1800-1004

INSPECTION

SLO-SYN Translators and Adjustable Speed Drives are designed to provide long, dependable service with a minimum of maintenance and adjustment. To assure proper performance, follow the procedures outlined in these instructions carefully. The "Damage and Shortage" instructions packed with the unit outline the procedure to follow if any parts are damaged or missing.

PRINCIPLES OF OPERATION

A SLO-SYN Translator translates into motor steps, information supplied as pulses from an external source or from an external shorting contact. For each element of stimulus, the motor shaft advances one step of 1.8°. As shown in Figure 1, a SLO-SYN Translator is a two-channel, bidirectional device. Incoming signals are shaped in monostable circuits before going to the logic elements, which consist of diodes and transistors arranged to provide the four-step sequence required to drive a bifilar SLO-SYN motor at 200 steps per revolution. The output from the logic elements feeds four transistor power switches which are connected to the four motor windings.

A SLO-SYN Adjustable Speed Drive is essentially the same as a SLO-SYN Translator, but includes a built-in oscillator to supply the triggering signals. If desired, the oscillator can be bypassed and the unit operated as a standard translator.

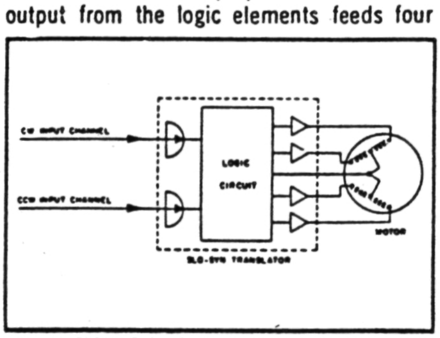


FIGURE 1 SCHEMATIC DIAGRAM

TEMPERATURE

A SLO-SYN Translator may be operated at any ambient temperature between 0°C and +40°C. It may be stored in transit at any temperature between −55°C and +85°C.

INSTALLATION

SLO-SYN Translators and SLO-SYN Adjustable Speed Drives can be rack mounted or may be mounted on a bench or shelf. For permanent mounting, drill four holes located as shown in Figure 2 and bolt the unit in place using the through holes in the cabinet feet. Be sure that nothing obstructs the free flow of air through the bottom of the cabinet and the louvers. When mounted inside a cabinet or other enclosure, the top cover may be removed for easier access and cooler operation. With the cover removed the maximum ambient temperature rating can be increased to +50°C.

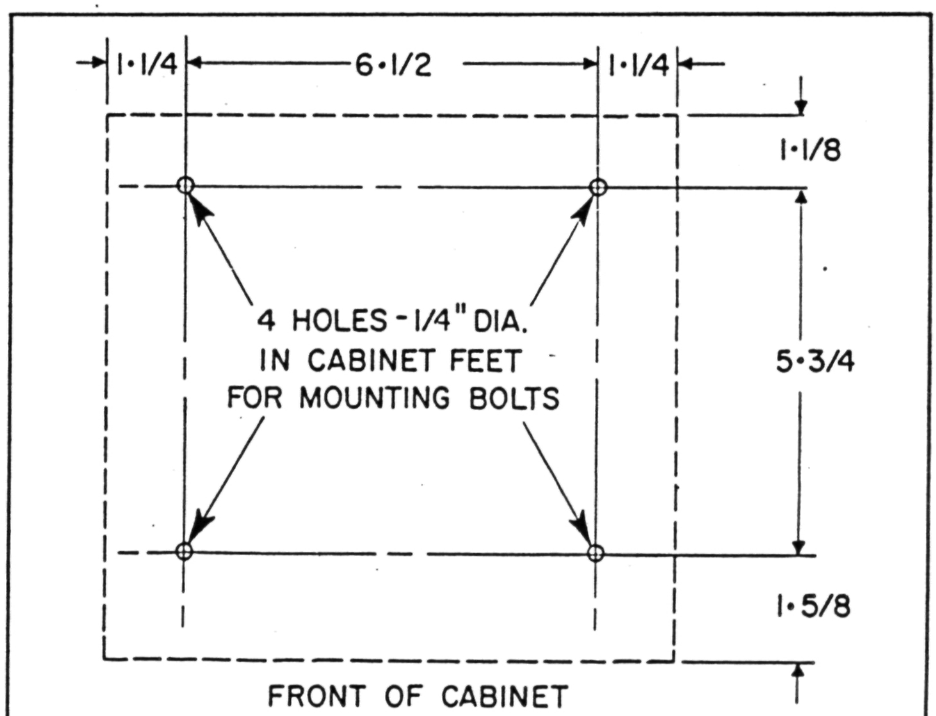


FIGURE 2 MOUNTING DIMENSIONS

THE SUPERIOR ELECTRIC COMPANY

Bristol, Connecticut 06012

FIG. 10a

POWER INPUT REQUIREMENTS

The required input is 105-125 volts, 0.5 ampere for type ST250B translator and type ST250B-1015 adjustable speed drive and 105-125 volts, 1.0 ampere for type ST1800 translator and type ST1800-1004 adjustable speed drive.

TRIGGERING SIGNAL REQUIREMENTS

PULSE OR SQUARE WAVE: The triggering requirement is a negative change of voltage at input terminal A for clockwise rotation or at input terminal B for counter-clockwise rotation, with respect to neutral terminal C. As shown in Figure 3, for a steep-front signal with a rise time of 0.1 millisecond or less, a negative amplitude change of 3 volts is sufficient. A signal with a more gradual rise will require a greater amplitude change. The unit will trigger on the leading edge of negative pulses and the trailing edge of positive pulses. Pulses can be supplied by tape readers, computers, oscillators, pulse generators or other signal producing equipment. The input impedance consists of a 2200 ohm, 0.5 watt resistor shunted by a series RC of 390 ohms and 0.1 microfarad.

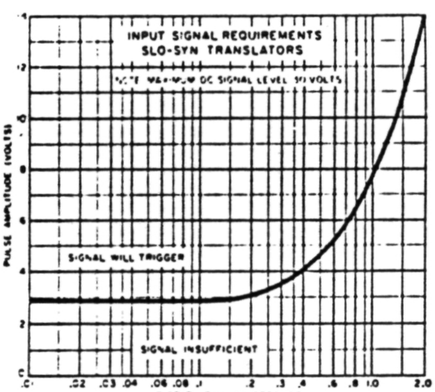


FIGURE 3

EXTERNAL SHORTING SWITCH: The unit can also be triggered using shorting switches as shown in the external wiring diagrams. Figures 4 and 5. Separate 12 volt positive d-c, 6000 ohm supplies are provided at input terminals X and Y on translators and at input terminal Y on adjustable speed drives. Connected to terminals A and B, they maintain a positive voltage at these terminals until the switch closes, thereby reducing the voltage momentarily to zero and providing the negative change of voltage needed to trigger the unit. Filtering of the closing bounce noise made by most mechanical switches is necessary to prevent faulty operation. Values of the RC noise filter components shown are typical and may have to be altered to suit the characteristics of the switches used.

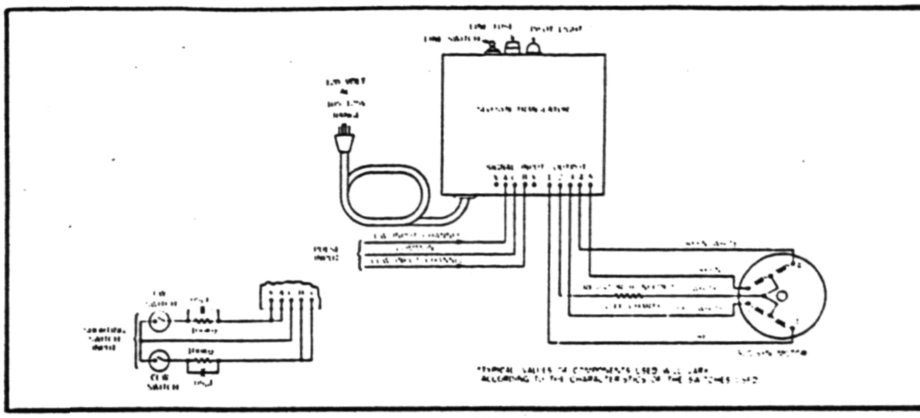


FIGURE 4 CONNECTION DIAGRAM SLO-SYN TRANSLATOR

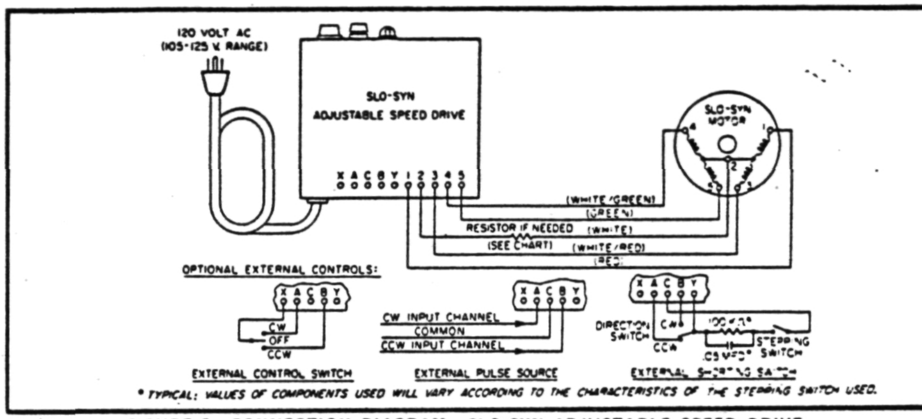


FIGURE 5 CONNECTION DIAGRAM SLO-SYN ADJUSTABLE SPEED DRIVE

TRANSLATOR OR ADJUSTABLE SPEED DRIVE		USED WITH BIFILAR MOTOR	DROPPING RESISTOR REQUIRED	
TYPE	INPUT AMPS	TYPES	DESCRIPTION	TYPE
ST250B ST250B-1015	0.5	SS25-1002	4 ohm ±5%, 25 watt	BP262-G21
		SS50-1009	2 ohm ±5%, 25 watt	BP262-G19
		SS150-1010 SS250-1002 X250-1002		
ST1800 ST1800-1004	1.0	SS250-1027 X250-1003 SS400-1021	1 ohm ±5%, 50 watt	BM102088-G5
		X1000-1002 SS1800-1007		

CONNECTIONS

NOTE: BEFORE CONNECTING THE SLO-SYN MOTOR, CHECK THE CHART TO BE SURE THAT THE MOTOR IS CORRECT FOR USE WITH YOUR TRANSLATOR OR ADJUSTABLE SPEED DRIVE. NEVER CONNECT OR DISCONNECT THE MOTOR LEADS WHILE THE UNIT IS ENERGIZED.

External wiring connections are shown in Figure 4 for SLO-SYN Translators and in Figure 5 for SLO-SYN Adjustable Speed Drives. It is also possible to operate two or more motors from a single translator or adjustable speed drive. The motors can be operated either simultaneously or one at a time, depending on the requirements of the application. Consult the factory for recommendations whenever a translator or adjustable speed drive is to be used with more than one motor.

Make the wiring connections in the following manner.

1. Connect the SLO-SYN motor to terminals 1 through 5 as shown in the wiring diagrams. Be sure that the motor leads are not shorted between terminals and that, when specified in the chart, a dropping resistor of the correct value is installed in the white (#2) motor lead.
2. Using the cord and plug assembly provided, connect the unit to a 120 volt a-c power source.
3. Make the input signal connections. If external shorting switches are used, the values of the RC filter network components can be altered later, if necessary, to suit the characteristics of the switches used.
4. SLO-SYN ADJUSTABLE SPEED DRIVES For external "forward-reverse" control, connect a single-pole, two position switch as shown in Figure 5. Connections for bypassing the built-in oscillator and operating the unit from an external source or from external shorting switches are also given.

FIG 10 B

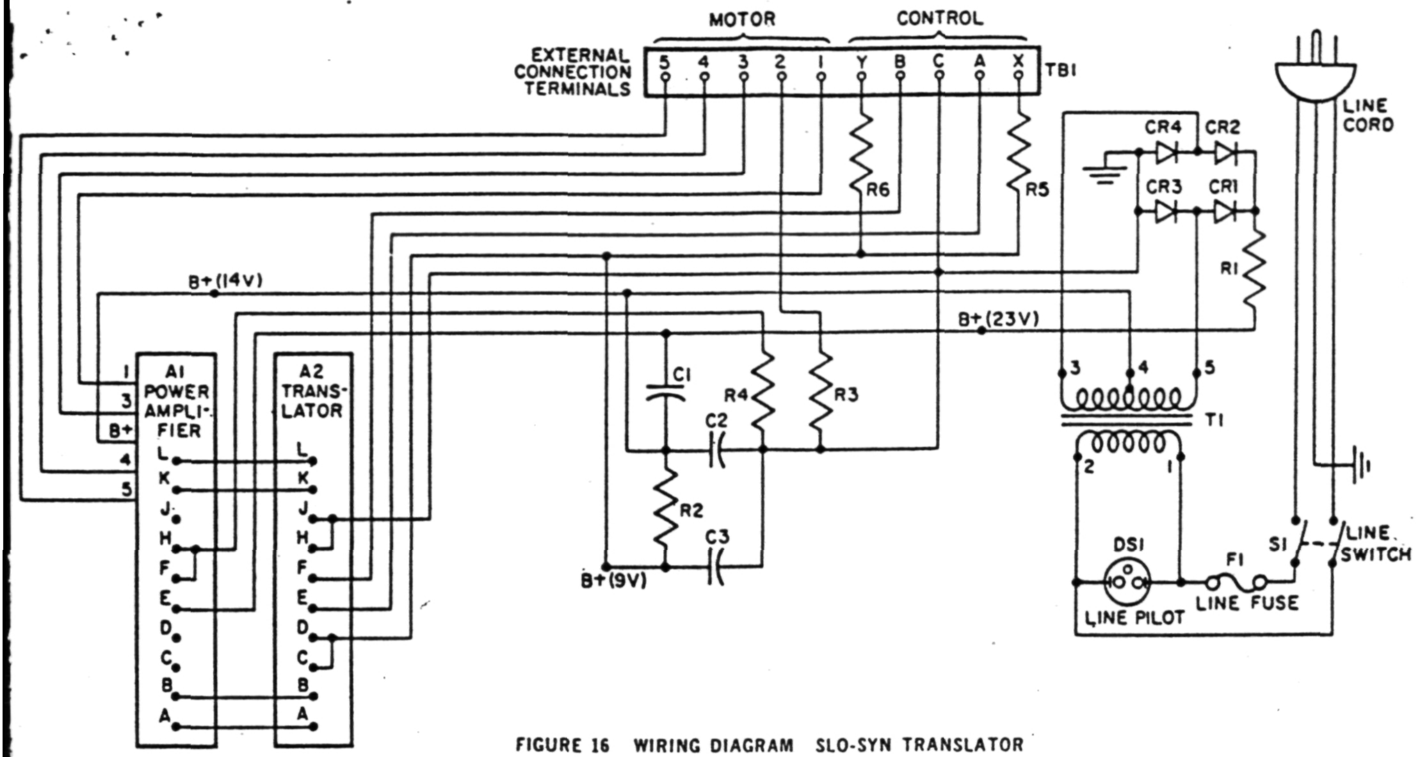


FIGURE 16 WIRING DIAGRAM SLO-SYN TRANSLATOR

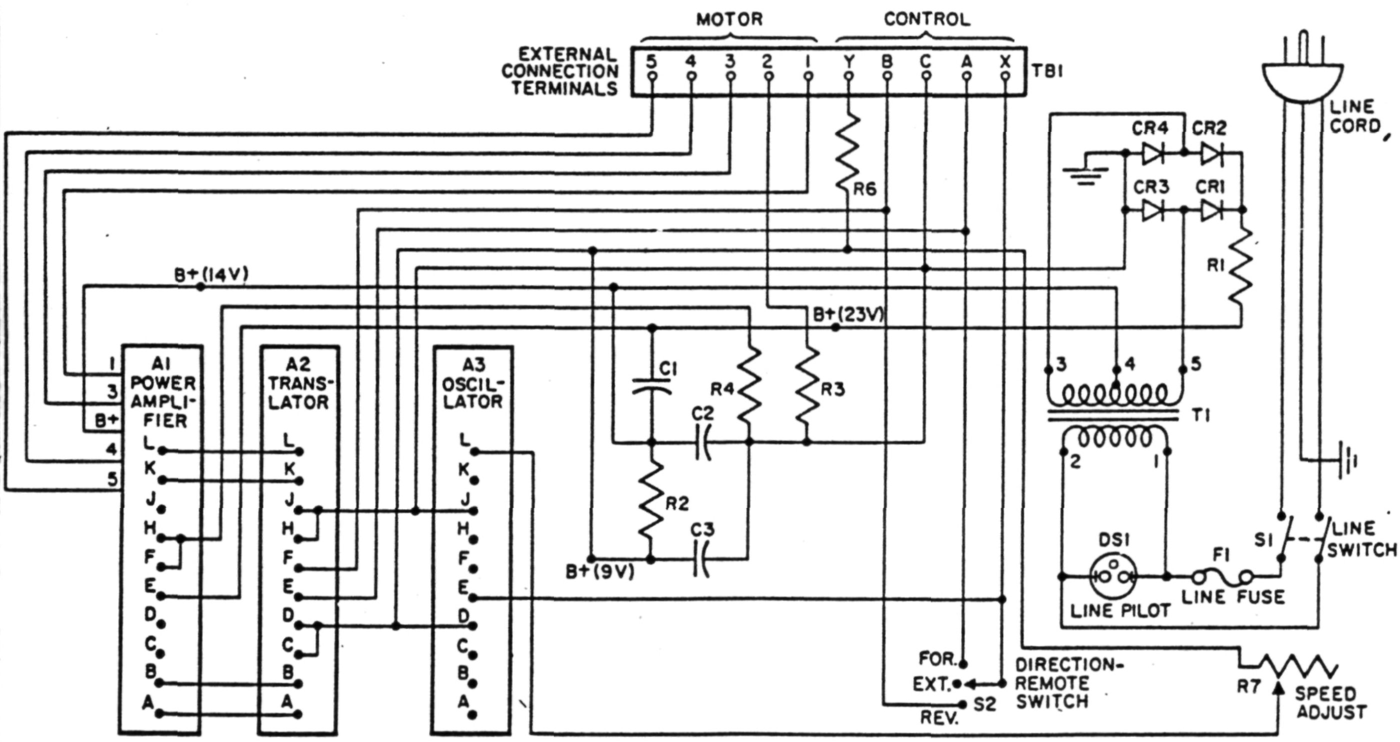


FIGURE 17 WIRING DIAGRAM SLO-SYN ADJUSTABLE SPEED DRIVE

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FIG 10c